

ROAD SAFETY ENGINEERING CHALLENGES IN BANGLADESH

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ABSTRACT

Road traffic accidents and injuries have now emerged as a serious man-made epidemic with an estimated 1.3 million people killed and as many as 50 million injured worldwide each year. Accidents are particularly prevalent in low and middle income countries- around 85 percent of the world's deaths occur in developing countries like Bangladesh. More than half of the world's traffic fatalities occur in the Asian-Pacific region although only one in five motorized vehicles are registered here. It is estimated that by 2020 about two-thirds of the world's traffic fatalities might be in the Asian-Pacific region. The road accidents statistics and characteristics revealed that Bangladesh has one of the highest fatality rates. About 70 percent of road accident fatalities occurred in rural areas including rural sections of national highways. Almost 80 percent of fatalities are vulnerable road users viz. pedestrians, bicyclists and motorcyclists. Pedestrian-vehicle conflicts are clearly the greatest problem with significant involvement of trucks and buses. The road factors are particularly prevalent in accidents and it is well known that the systematic road design and engineering improvements can prevent many such accidents and save lives quickly and affordably. Indeed, road safety issue in Bangladesh thus posits a considerable challenge to the road engineering professionals. In this paper an attempt has been made to highlight the road safety issues and priorities in Bangladesh with particular emphasis on the road safety engineering challenges and opportunities.

1. INTRODUCTION

According to the latest published literature, each year 1.3 million are killed and at least 50 million are injured in road traffic accidents globally. More than 85 percent of these casualties including 96 percent of child deaths occur in low and middle income countries (Make Roads Safe, 2008). It is predicted that the number of people killed on roads will rise by at least 80 percent over the next 20 years in developing countries like Bangladesh. More than half of the world's traffic fatalities occur in the Asian-Pacific region although only one in five motorized vehicles are registered here. It is estimated that by 2020 about two-thirds of the world's traffic fatalities might be in the Asian-Pacific region. Indeed, road safety situation in Bangladesh has worsened in recent years. The number of reported traffic fatalities increased nearly four times over the last 25 years, 1982-2007. In this paper an attempt has been made to highlight the road safety characteristics, issues, and priorities in Bangladesh with particular emphasis on the challenges and opportunities of road safety engineering approaches to reduce accidents and casualties.

2. CURRENT ACCIDENT SITUATION ON ROADS IN BANGLADESH

Road Safety Overview

There were at least 3749 reported fatalities and 3273 injuries in 4869 accidents in Bangladesh in 2007. It is estimated that the actual fatalities could well be at least 12,000 each year and many more sustain disabling injuries. In economic terms, road accidents in Bangladesh costing community in the order of Tk. 5000 crore (US \$ 850 million) which is nearly 2 percent of GDP. The number of fatalities has been increasing from 1009 in 1982 to almost 3749 in 2007, nearly 4 times in 25 years period showing an increasing trend in recent years. The statistics revealed that Bangladesh has one of the highest fatality rates in road accidents.

About 70 percent of road accident fatalities occurred in rural areas including rural sections of national highways. Also it has been observed from the studies that up to 62 percent of urban road accident deaths are pedestrians alone and in Dhaka city, they represented nearly 70 percent. Almost 80 percent of fatalities are vulnerable road users e.g. pedestrians, bicyclists and motorcyclists. Pedestrian-vehicle conflicts are clearly the greatest problem with significant involvement of trucks and buses. Children are highly vulnerable in the traffic situation compared with many other countries of the world.

The Nature of the Accident Problem

A comprehensive analysis was undertaken of all reported accidents in Bangladesh in the period 1998-2005. Most striking characteristics of accidents are:

- The statistics revealed that Bangladesh has one of the highest fatality rates internationally in road accidents, over 100 deaths per 10,000 motor vehicles.
- About 70 percent of road accident fatalities occurred in rural areas including rural sections of national highways.
- Of the total reported accidents nearly 37 percent occurred on national highways.
- Accidents and fatalities on national highways are characterized as clustering on selected sections, identified as Hazardous Road Locations (HRLs), nearly 40 percent of accidents concentrated on around 2 percent of the highway network.
- Accident type analysis showed 'hit pedestrian' as the dominant accident type both in urban and rural areas, 45 percent involvement in fatal accidents. Other common accident types are: rear end collision (16.5%), head on collision (13.2%) and overturning (9.3%).
- Heavy vehicles such as trucks and buses including minibuses are major contributors to road accidents (bus/minibus 33%, trucks 27%) and in fatal accidents their shares are 35 percent and 29 percent respectively.
- The incidence of overall child involvement in road accident fatalities in Bangladesh is found to be also very high, accounting for about 21 percent.
- Road traffic accidents are the leading cause of deaths for 10-14 years old children.
- Up to 61 percent of urban road accident deaths are pedestrians alone. Pedestrians accounted for 49 percent of all reported fatalities in the accident database.
- Accidents occur more frequently at day time (6 am to 6 pm): day time 75 percent, and night time 25 percent in rural areas: day time 65 percent and night time 35 percent in urban areas.
- Nearly 22 percent of all reported accidents in Bangladesh occurred in Dhaka Metropolitan City.
- About 2.5 percent of reported accidents occurred on bridges and culverts
- The principal contributing factors to accidents are adverse roadway roadside environment, poor detailed design of junctions and road sections, excessive speeding, overloading, dangerous overtaking, reckless driving, carelessness of road users, failure to obey mandatory traffic regulations, variety of vehicle characteristics and defects in vehicles and conflicting use of roads

Major Issues of Concern

Apart from the preceding accident characteristics other road safety issues of concern are:

Under-reporting accidents: The widespread underreporting and incomplete collection of specific details of accident data are a major problem. This limits proper accident analysis to be carried out towards improving and monitoring road safety

Defective and road unworthy motor vehicles: Presence of defective and road unworthy motor vehicles on road poses a threat to safety of road traffic. The most common defects of vehicles in Bangladesh appears to be worn out tyres, loose wheels, overloaded axle, faulty brake and indicator lighting system etc. There is urgent need for undertaking immediate safety initiatives before it becomes worsen with increasing motorization and high standard of roads.

Drivers incompetency: Incompetent drivers and driving with open and widespread use of fake licenses appear to a major concern to safety on our roads. Strict licensing requirement is critically important. Effective driver testing, good control and registration of driving schools and driving instructions are priority requirements.

Road engineering and environmental deficiencies: Significant and serious road safety engineering and design deficiencies are most prevalent in many locations. There is specific need and much scope for road environmental improvements aimed at correcting the most common deficiencies through wider application of traffic engineering and public health approaches. At least 40 percent of accidents could be reduced through road engineering and environmental improvements.

Inadequacy in police inspection and law enforcement: The current level of traffic law enforcement, vehicular regulations and road users education is exceedingly low in Bangladesh and efforts in this regards require strengthening. The deployment of police traffic law enforcement based on high-risk locations and times is essential specially concentrating on moving offences and preventing unsafe driver behaviour.

Poor road user behaviour and safety education: Road user behaviour is much less disciplined than desirable. There is clearly a need to improve road safety education and improved road user behaviour and knowledge. Extensive research on human factors in accidents could contribute significantly understanding of road users' behaviour involved in accidents. Detailed investigation is also necessary to identify the gaps and deficiencies in the perceived traffic safety knowledge of road users, particularly drivers of heavy vehicles.

Institutional weakness: Road safety improvement efforts in Bangladesh seriously suffer from several serious drawbacks. These are lack of strong professional safety agency with adequate executive powers and responsibilities; fragmentation of responsibilities between agencies and insufficient inter-agency coordination; low level of staffing and lack of professional capacity; lack of trained traffic police for effective enforcement and traffic regulations; absence and inadequate dissemination of road safety research, and too few resources directed towards tackling the safety problem etc.

3. IMPROVING ROAD SAFETY: SOME PRIORITIES AND CHALLENGES

It is possible to significantly reduce the number of road accidents and casualties by implementing an effective and coordinated safety policy and actions which require significant improvements in the relevant sectors viz. better enforcement, better roads, enhanced vehicle safety standards and improved public education programs.

Some Traffic Safety Priorities

Based on the understanding of the problem characteristics some emerging road safety priorities and issues which should be addressed with due urgency were identified. These priority issues are (see for example, Hoque et al. 2007; Hoque, 2006):

- Reducing and control of vehicular speeds: excessive and inappropriate travel speeds and dangerous undesirable overtakings are of particular concern, affecting road safety. There is evidence that reducing speed is probably the most powerful instrument to reduce injuries and deaths and is regarded as a very cost effective measure.
- Promote pedestrian and non-motorists safety as a priority issue with emphasis on safety of children on roads as pedestrian fatalities are particularly high in Bangladesh both in the urban and the rural areas.
- Treatment of known Hazardous Road Locations (Blackspots and Blacksites) as they accounted for a large number of accidents and casualties and their treatments are highly cost-effective.
- Introduction of the road safety audit process into the road planning, design and construction processes as well as safety inspection and assessment of existing roads.
- Incorporation of safety features in the design and construction of new roads scheme and corrections of prevailing road infrastructure deficiencies through roadway design and environmental modifications setting standards and developing appropriate design guides.
- Addressing the issue of over involvement of buses, minibuses and trucks in road traffic accidents and casualties including passengers traveling on overloaded buses and their roof tops as well as load carrying trucks.
- Catering non-motorized and slow moving vehicles on roadways and streets: sensible segregation and special facilities (e.g. service lanes) on arterials and highways in an effort to minimize conflict and hazards.
- Addressing motorcyclists and locally designed non-formal three-wheeled vehicular safety issues and requirements.
- Setting up and running road safety demonstration/plot projects for learning and creating and building local safety expertise through active intersectoral partnerships.
- Prevention and reduction of dominant accident types and their severities that contribute to the high incidence of traffic fatalities and injuries (viz. hit pedestrian, head-on collision, run-off the road and out of control type accidents).
- Development and implementation of community based road safety programs and road side hazards management.
- Prompt emergency assistance and efficient trauma care management are clearly important in minimizing the road accident deaths and therefore should be introduced.
- Strengthen and co-ordinate accident and casualty data collection system (police, hospitals and insurance data) involving different agencies and research organizations.
- Research is vital to provide knowledge towards understanding and tackling accident problems and to develop standards and new measures for safer roads and evaluate and monitor trends and programs. Detailed scientific analysis of accidents and casualty data is crucial to develop and undertake effective countermeasures to improve the current road safety scenario. It is also important to foster safety research excellence through exchange and linkage with institutions at regional and international levels.

Apart from these, other priority safety areas are traffic enforcement, safety conscious behaviour of road users, vehicle standards, emergency assistance and trauma care, safety management capacity building, funding availability, collaboration and sharing of knowledge, experience and good practices. Detailed discussions could be seen in Hoque et al. 2007.

Importantly, the long term solution to road accident problems particularly in rural areas is to provide a higher quality road system with increased length of divided highways, which have a better safety record than undivided highways. The safety of the vulnerable road users must also be sufficiently catered for in the road safety strategies and principles. Vulnerable road users are

much more susceptible to accidents when vehicle speeds are high and can even suffer fatal injuries in accidents with motor vehicles at moderate speeds. Potential approach to protect these users is by giving special consideration in designing vehicles and roads to ensure they are not unnecessarily exposed to high speed traffic.

Major Traffic Safety Challenges

Successfully dealing with these priority areas is most likely to have the greatest potential to reduce road trauma and is likely to bring about substantial improvements in safety in Bangladesh. They are indeed major traffic safety challenges in Bangladesh where there is very little safety expertise available to deal with road safety issues holistically. There are encouraging signs and has been some progress with road safety organizations, establishment of accident research institute and preparation of strategic road safety action plan.

However, with the current state of efforts and initiatives, it appears most unlikely to bring about any noticeable safety improvements. Road traffic accidents and fatalities cannot be expected to decrease rapidly and substantially unless focused and continuous efforts with scientific based are put in place with a sense of urgency. In particular there is a urgent need to accelerate implementation of problem specific countermeasures, policies and conduct of good practice based on efforts of enhanced understanding, scientific analysis, monitoring and research. One fundamental step to be taken by the government is to create an organization dedicated to initiating and coordinating road safety activities as well as by activating lead agencies with a mandate of implementing very specific and explicit actions and strategies. In particular efforts should be strengthen on the following aspects:

- Making road safety a policy priority, setting up of goals and objectives;
- Designating a single central agency with the authority to address road safety;
- Activating lead agencies in relevant sectors with appropriate authority, co-ordination and resource availability and to monitor and evaluate improvements;

There is an urgent and obvious need for developing priority safety programs giving special attention to hazards on highways and streets with high-accident experience. It is now abundantly clear and should be noted that engineering, road safety engineering in particular can and should play a leading role in road safety (see Anderson 1976). The underlying contention is that safety engineering practice particularly low cost engineering improvements can indeed contribute the lion's share to the reduction of accidents and casualties on the roadway system (Snyder 1972; Anderson 1976; Lay 1988; Ogden 1996, iRAP 2008). This observation is especially cogent to the situation in Bangladesh where there is specific need and much scope for road environmental improvements aimed at correcting the most common deficiencies through wider application of traffic engineering approaches emphasizing on low cost engineering based improvement schemes. The following section of the paper aims to discuss the role and the promising areas road safety engineering approach for reducing accidents and casualties.

4. THE ROLE OF ROAD SAFETY ENGINEERING AND OPPORTUNITIES

The Role of Road Safety Engineering

Road traffic accidents result from failures in the interaction of humans, vehicles and the road environment- the elements that produce the road traffic system. The combination of these various elements to produce road accidents means that the road safety itself has to be tackled in a multi-functional manner in order to break the chains of events that lead to accidents and the eventual injuries of road users. An integrated, multi-disciplinary approach is required to reduce road accidents and consequent injuries and economic losses. Importantly, the road component remains a major consideration in the overall road safety management strategies. Indeed, as Fisher and Camou (1977) remarked, the road component is a most important determinant of traffic accident frequency.

Evidence suggested that road related factors contribute to about 30 percent of accidents. However various studies (Ogden, 1996) indicated that even a greater proportion, perhaps 40 percent or more, of accident reductions could reasonably be expected to accrue from the provision of a safer road environment. According to Anderson (1976) road environmental improvements had shown more substantial results on highway safety than the results of both vehicle and driver programs combined. He asserted that through highway safety improvements, the nations accident toll could be reduced by at least 50 percent. The Japanese success in the 1970s in halving its traffic accidents was brought about mainly by traffic engineering measures to improve the road and roadside environment (Koshi 1986). In the UK program established in 1987 to reduce road accident casualties by one-third by the year 2000, road safety engineering measures were expected to deliver at least one-third of this target reduction (Burrough 1991; Sabey 1995). Indeed, in its review the European Transport Safety Council (ETSC 1996) recommends that the systematic application of low-cost road and traffic engineering measures continues to be one of the most cost-effective tools for reducing road accidents and consequent death, injury and damage throughout the European Union in the coming years.

Clearly the potential of the road safety engineering approach has been very well recognized, as this approach can aid and influence road users to change their behaviour, act safely and can make the road environment safer through reducing conflicts and in particular making road environment more "forgiving". Innovative engineering design actions are particularly effective to protect vulnerable road users and make them safer via traffic segregation, traffic calming, service roads, roundabout and other user-friendly designs (Tiwari et al., 2005). By using known traffic engineering skill and ingenuity, it is possible to provide a more reasonable accommodations and forgiving environment for pedestrian traffic (Anderson 1976). Consequently there has been a sustained growth in emphasis on engineering and planning countermeasures over the past three decades worldwide.

Indeed, many of the observed characteristics of accidents and fatalities are indicative of problems and deficiencies associated with road infrastructure and environment. It is therefore time for countries like Bangladesh to quickly tighten this area of road safety engineering practice through sustained understanding, innovation and commitment with due regard to the learning of the complex phenomena of accidents involving road, human, vehicle, psychological and technological factors and with particular consideration of the prevailing conditions, social acceptability and requirements of the vulnerable road users. It should be understood that road safety involved shared and co-operative responsibilities of broader alliance of many sectors, professions and disciplines (engineering, technology, education, law, enforcement, psychology, community and health and emergency care and others). Engineering is one and perhaps the leading one to address such enormous road safety challenges. In fact it is the moral responsibility of road engineering professionals to protect the safety of the road users (Anderson 1976). This responsibility and obligation needs to be understood and deliver by road engineers putting safety into its proper perspectives which would require significant specialized training and awareness programs in Bangladesh.

Road Safety Engineering Strategies and Opportunities

Road safety engineering may be defined as a process based on analysis of road and traffic related accident information, which applies engineering principles in order to identify road design and traffic management improvements that will cost-effectively reduce the cost of road accidents (Ogden 1996). The challenge in road safety is to identify what is common about the actual causal chain across a range of accidents, and to apply measures which will break the chain for a number of accidents. This is the power of the road safety engineering approach; where a common road related feature can be identify across a range of accidents, remedial action to remove or modify that feature likely to be highly cost effective. The opportunities for road safety engineering in general apply at four levels (TRL Guide 1991):

- safety conscious planning of new road networks including the application of road safety audits,
- incorporation of safety features and good standards in the design of new roads,
- improvement of safety aspects of existing roads to avoid future problems, and
- improvement of known hazardous locations on the road network (black spot programs aimed at crash reduction).

These opportunities for the application of road safety engineering are conveniently grouped into two important strategies of *accident prevention* and *accident reduction* (Sabey, 1995). Accident prevention is achieved through the application of safety principles in the provision, improvement, and maintenance of roads and predominantly relates to the first three opportunities. Accident reduction is achieved through the application of cost-effective measures on existing roads and essentially relates to the fourth opportunity. This covers techniques for identification of hazardous road locations, diagnosis of problems, selection of treatment, and evaluation (Sabey, 1995). Both strategies have played a major part in achieving greater safety on the road network. For the future, it is particularly important to augment and maintain the impetus in road safety engineering by the introduction of newly developed measures and approaches.

Some typical approaches to improving the safety of the road environment are (Downing 1992)

Accident prevention: improved planning of new roads and development particularly in urban areas. Basic principles include

- Land-use should be distributed to minimize vehicle trips and pedestrian vehicle conflicts
- Network should be classified into a hierarchy with the emphasis of speed management.
- Layouts of roads in residential areas should be designed to keep out through traffic and keep speeds down to appropriate levels
- New scheme should be checked exclusively for safety i.e. road safety audits

Accident reduction: application of cost-effective measures on existing roads:

- Low-cost engineering improvements at hazardous locations and high risk sites
- Area (urban) wide schemes providing pedestrian and cyclists facilities
- Traffic calming, controlling speeds and parking

It should be particularly noted that the benefits and effectiveness of road safety engineering measures could be best achieved by the systematic understanding of and constant reference to the fundamental safety principles and operational elements of safer road designs. Therefore the development and implementation of countermeasures should by and large follow the main principles of a safe road environment as outlined below:

- to provide guidance: guide the driver through unusual sections;
- to provide information: inform the driver of conditions to be encountered;
- to warn: warn the driver of any substandard or unusual features;
- to control: control the driver's passage through conflict points or sections; and
- to forgive: forgive the driver's errant or inappropriate behaviour.

An emerging aspect of identification of potential countermeasures and treatment options is that the essential goal should be a reduction in total harm of accidents based on exposure, risk and consequences (Mohan et al., 2009). It is important that engineering road safety practice takes note of this approach as well. It is also important that engineers understand and must be aware of the part that human factors play and realized that traffic engineering applications and countermeasures work through their influence of human behaviour (Sabey 1995; Ogden 1996).

Some Urgent Actions of Road Safety Engineering

Under the prevailing conditions, the authors consider that the following promising actions of road safety engineering approach are of prime importance for road safety improvements in Bangladesh.

Accident Black Spot Treatments: Spot safety programs - those that seek to identify, prioritize and treat accident locations that are statistically aberrant have been very successful (Polanis, 1995). There is specific need and scope for road environmental improvements aimed at correcting the most common deficiencies in hazardous road locations and accident black spot in Bangladesh. Accident black spot treatments have demonstrated high economic benefits and therefore demand priority consideration in Bangladesh. Desirably, emphasis should be placed initially on introducing low cost improvement schemes which proved to be highly effective. Typical such safety measures are incorporation and treatments of road shoulders, pedestrian facilities (segregated footways, crossings), junction improvements, treatment of hazards, speed control devices, median barriers, access control, canalization, traffic islands, skid resistance treatment, improved delineation devices, safety zones etc. including provision of divided roads. Further details of low cost accident remedial measures can be seen in Hoque et al (2006). Observational and on-scene in-depth studies of selected hazardous locations clearly demonstrate the urgency of strengthening accident remedial works through systematic and widespread application of low-cost road and traffic engineering measures with due regard to the related issues of accident migration effects.

Road Safety Audits: Alongside accident reduction work, accident and injury prevention work must also be pursued through road safety audit as an important process in road safety engineering. Road safety audit being a systematic examination of roadway elements for safety would focus on explicit safety implications and recommend desirable changes or modifications in highway design and operational aspects appropriate to the local safety needs (Hoque et al 2001). Road safety auditing or checking is a very essential and systematic step that needs to be introduced to document such widespread safety deficiencies for appropriate corrections. Proactive identification and treatment of accident black spots through road safety audit is considered to be highly beneficial to Bangladesh context. Regular audit of existing roads allow road safety hazards to be identified before they result in accidents. Common safety issues to be addressed include:

- Special safety provision and requirements of Vulnerable Road Users (VRUs).
- Bus stops including stationary/broken vehicles and roadside activities have significant traffic operational hazards.
- Inadequate and/or absence of delineation devices
- Roadside objects and the provision of clear zones
- Access control and conflicts minimization.

Road Inspections and Assessment: This approach has now emerged as a new tool for systematic analysis of road infrastructure deficiencies and provides targeted countermeasures programs to improve road safety across an entire road network. The tools particularly address the safety of vulnerable road users and assess each stretch of roads for its safety for pedestrians, bicyclists, motor cyclists and car occupants separately. The methodology offers 'vaccines for roads' are therefore demands priority consideration in Bangladesh for its application with international collaboration. It is important to note and learn that effective safety management of existing road network require infrastructure improvements at targeted locations throughout the road network apart from focusing on just a few black spots that might have high short term accident experience (iRAP, 2008). The ongoing efforts of the International Road Assessment Programme (iRAP) for low and middle income countries could well be extended to Bangladesh and is seen particularly beneficial to develop local road safety capability. The iRAP targets high-risk roads where large numbers are killed and seriously injured and inspects them to identify where affordable programs of safety engineering can reduce large number of deaths and serious injuries on the basis of strong partnership for key local stakeholders.

It should be noted that road traffic safety professionals can only prevent accidents if they understand what causes them. Traditionally, this understanding is achieved through systematic accident investigation and scientific research on road traffic accidents. Importantly, therefore, the pursuit of the above road safety engineering practices however would require the following aspects:

- Real understanding of the underlying road safety problems/trends, their characteristics and the factors involved through detailed analysis and studies of accidents based on disaggregated sound accident data systems (to ensure reliability, consistency and accuracy) and using systematic accident investigation methodology/techniques.
- Clear understanding of the known relationships between accidents experience/rates and various roadway and traffic engineering design elements/features (link between the site characteristics and accident characteristics) and
- Knowledge of the safety benefits to be obtained from various measures, particularly the potential and likely effectiveness of low cost road and traffic engineering measures and improvements.
- Create a competent cadre of professionals specifically trained in road safety issues and developments of new perspectives on road safety management (safe system approach), supported by developing programs for training and research (see e.g. Tiwari et al. 2005, Breen, 2008).

5. CONCLUSIONS

This paper has in brief introduced the road safety problem in Bangladesh in terms of its factors and striking characteristics. The road safety issues, approaches and the required efforts discussed in the paper are considered to be significant challenges in Bangladesh. The way forward to greater road safety on roads indeed demands greater co-operation between the all concerned by stimulating sustainable and structured efforts in dealing with the problem. Importantly, the remedy lies in urgent action to the development of systematic road safety practice through implementation widespread countermeasures, road engineering measures in particular using scientific principles and programs. The role and potential of road safety engineering approaches and opportunities are reviewed in the light of their applications for substantial improvements of road safety in Bangladesh. The role of local road engineering professionals in this regard is vital for which intense training, awareness and research programs should be contemplated with due urgency.

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